ASOS Trainer's

Tool Box

For a Better Understanding of Automated Surface Observing Systems

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The Tipping Bucket Rain Gauge

The days of manually measuring precipitation with a bucket and ruler or with a strip chart weighing gauge are coming to an end. With the introduction of ASOS, came the need for an automated precipitation accumulation gauge, or, at least for the present, an automated rain-only gauge.

The current precipitation accumulation gauge ASOS uses is a heated tipping bucket manufactured by the Frise Engineering Company of Baltimore, MD (see figure Page 2). Essentially, it is a revamped version of the old Belfort tipping bucket, widely used for decades. Today's Frise Tipper uses several design modifications that have either solved or mitigated a number of performance flaws in the original design. These modifications allow the new automated gauge to perform close to the old manual gauges, which serve as the "standards" in the testing world.

The Frise gauge works by catching precipitation in a 12-inch diameter open funnel, called the collector. Once collected (and, if necessary, melted by internal heating strips), the water is funneled to a mechanical device called the tipping bucket. The bucket works much like a seesaw with a container ("bucket") on each side.

The bucket on the raised end of the tipper is positioned directly beneath the collector spout, collecting the water first. The seesaw tips when the bucket collects the equivalent of 0.01" of rainfall. Each tip empties one side of the seesaw and positions the other bucket under the funnel. During the tipping process, a magnet moves past a sensor (a reed switch) and signals that it has accumulated 0.01". After each tip, the measured water is funneled out the bottom of the gauge.

To Tip or Not to Tip?

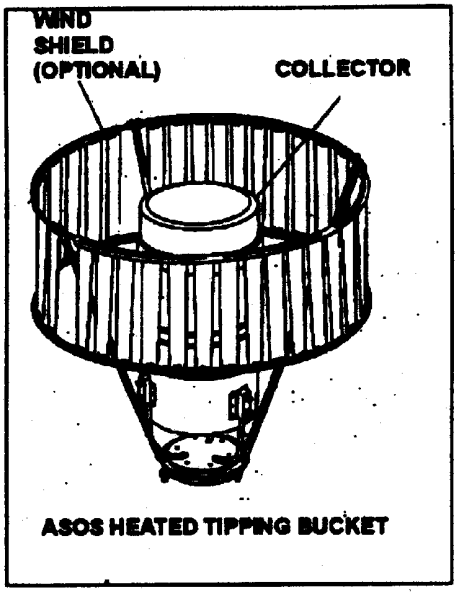
How well does the ASOS tipping bucket measure up? Well, that depends on what you're trying to measure. In the past, measuring rain or melted snow with a ruler and bucket or with a simple strip chart weighing gauge was a relatively easy and accurate process. A drawback with the older gauges is that they required someone to melt the snow and take the measurement or to read the strip chart. They also didn't enable the timeliness that is desired and possible with automated systems.

What do you lose by eliminating the human factor and automating with a heated tipping bucket? The answer is very little of the rainfall but about 40% to 50% of the liquid equivalent of the snowfall. While fully modified tippers achieve excellent results with rain (less than 4% difference from manual gauges), several factors affect the heated tipping bucket's performance with snow.

Probably the biggest loss of snow "tips" is due to evaporation when the collector heaters attempt to liquefy snow. Another loss occurs when snowflakes are deflected away from the collector by the "chimney effect," warmed air rising from the gauge when the heaters are operating. Perhaps the most confusing of problems occurs when a slab of snow and/or ice melts well after an event has ended, often more than a day later. This can cause record-keeping headaches!

The Tipping Bucket Grows Up

The heated tipping bucket has never performed well with snow. Until recently there were also serious questions about its effectiveness in measuring rainfall. Problems with tippers included sticking due to corrosion, water splashing or missing the tipper, and unreliable mercury switches, which often missed tips during precipitation or recorded false tips during windy conditions.



ASOS HEATED TIPPING BUCKET

Vigorous research since 1992, at the NWS Research and Development Center in Sterling, VA, and Winter Test Site at Johnstown, PA, have helped to uncover these problems and to develop and test possible solutions.

Solutions include replacing metal contact points with non-corroding polyethylene, extending the funnel spout closer to the tipper to reduce splashing and lost water, and changing from the mercury switch to a reed switch.

The change to reed switches eliminated both missed and false tips. These modifications brought the tipping bucket's performance up to the ASOS specifications for liquid precipitation events.

Ideally, an automated precipitation accumulation gauge should measure all types of precipitation. The heated tipping bucket does not perform well with frozen precipitation, especially snow. As a result, the gauge is used as a "liquid" accumulation sensor only. The next big question: can the tipping bucket be improved further to adequately measure snowfall or will a new gauge design be necessary?

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